CLAIMS:

1. A method for automatically generating a key and a conjugate key to be used in an optical code division multiple access system, the method comprising applying a down conversion process to pump input light to thereby produce down converted broadband signal and idler fields that are complex conjugates of each other, said signal and idler fields serving as the key and its conjugate.

2. The method of Claim 1, wherein said down conversion process comprises passing the pump light through a non-linear optical medium.

3. The method of Claim 1, wherein said down conversion process comprises passing the pump light through an optical arrangement having a resonant cavity formed by at least one non-linear optical medium between two reflectors.

4. The method of Claim 3, comprising reducing an effect of up conversion of the down converted light fields propagating through the resonant cavity.

5. The method of Claim 4, wherein said reducing of the up conversion effect comprises applying a spectral phase shaping to at least one of the down converted light fields while propagating through the optical arrangement.

6. The method of Claim 5, wherein said spectral phase shaping comprises introducing a relative delay between the down converted signal and idler fields emerging from the non-linear medium, and restoring the phase relation of the signal and idler fields prior to further passing through the non-linear medium.

7. The method of Claim 6, wherein said relative delay is of the order of the coherence time of the respective down converted field $\tau=1/\Delta\omega$, wherein $\Delta\omega$ is the spectral width of the down converted light.

8. The method of Claim 1, wherein said down conversion process is carried out at a data transmitting side.

9. The method of Claim 1, wherein said down conversion process is carried out at a data receiving side.

10. A method for use in an optical code division multiple access (CDMA) system, the method comprising: applying a down conversion process to a light channel that

is to be used for carrying data from a data transmitting system to a data receiving system, said down conversion of the light channel automatically producing broadband signal and idler light fields that are complex conjugates of each other and therefore serve as a key and its conjugate, thereby enabling data modulation of at least one of the signal and idler fields and processing them together by applying an up conversion process to thereby extract the data.

**11.** A method for use in an optical code division multiple access (CDMA) system, the method comprising at least one of the following:

- applying a down conversion process to a light channel that is to be used for carrying data from a data transmitting system to a data receiving system, said down conversion of the light channel automatically producing broadband signal and idler light fields that are complex conjugates of each other and therefore serve as a key and its conjugate, thereby enabling modulation of at least one of the signal and idler fields with said data and processing the signal and idler fields together to extract the data; and
- applying an up conversion process to data-carrying light, containing down conversion signal and idler fields presenting an optical channel, thereby restoring light indicative of the data channel in a data receiving system.

**12.** The method of Claim 10, wherein said down conversion process is applied to the light channel in the data receiving system, and one of the signal and idler fields is transmitted from the receiving system to the data transmitting system, thereby enabling the data modulation of said one of the signal and idler fields at the data transmitting system.

**13.** The method of Claim 10, wherein said down conversion process is applied to the light channel in the data transmitting system.

**14.** The method of Claim 11, wherein said down conversion process is applied to the light channel in the data receiving system, and one of the signal and idler fields is transmitted from the receiving system to the data transmitting system, thereby enabling the data modulation of said one of the signal and idler fields at the data transmitting system.

**15.** The method of Claim 11, wherein said down conversion process is applied to the light channel in the data transmitting system.

**16.** A method for producing an optical channel in an optical code division multiple access (CDMA) system, the method comprising: applying a down conversion process to input light, to be used for carrying data from a data transmitting system to a data receiving system, said down conversion process producing down converted signal and idler light fields that are complex conjugates of each other and therefore present a key and its conjugate, thereby enabling uniquely affecting a spectral phase of at least one of the signal and idler fields to define a unique phase relation between the signal and idler fields, and enabling extraction of data by utilizing an up conversion process.

**17.** A method for producing an optical channel in an optical code division multiple access (CDMA) system, the method comprising:

(i) applying a down conversion process to input light, to be used for carrying data from a data transmitting system to a data receiving system, said down conversion process producing down converted signal and idler light fields that are complex conjugates of each other and therefore present a key and its conjugate;

(ii) uniquely affecting a spectral phase of at least one of the signal and idler fields to thereby define a unique phase relation between the signal and idler fields, thereby enabling extraction of data by utilizing an up conversion process.

**18.** The method of Claim 16, wherein one of the signal and idler fields is used for data modulation, said uniquely affecting of the spectral phase is applied to said one of the signal and idler fields.

**19.** The method of Claim 16, wherein one of the signal and idler fields is used for data modulation, said uniquely affecting of the spectral phase is applied to the other one of the signal and idler fields.

**20.** The method of Claim 18, wherein said down conversion process is carried in the data transmitting signal which carries out the data modulation.

**21.** The method of Claim 19, wherein said down conversion process is carried in the data receiving signal.

**22.** The method of Claim 19, wherein said down conversion process is carried in the data transmitting signal which carries out the data modulation.

**23.** The method of Claim 16, comprising operating the data receiving system to carry out the following:

applying said down conversion process, transmitting one of the signal and idler fields to the data transmitting system, thereby enabling the data transmitting system to modulate said one of the signal and idler fields with the respective data, a certain distance between the data receiving and data transmitting systems defining said unique phase relation between the signal and idler fields, applying the unique effect of the spectral phase to the other one of the signal and idler fields; and upon receiving the data modulated field applying the up conversion process to the spectral phase affected data modulated field and the other spectral phase affected field.

**24.** The method of Claim 16, comprising operating the data transmitting system to carry out the following:

applying said down conversion process;

modulating one of the signal and idler fields with the respective data;

carrying out said uniquely affecting of the spectral phase of at least one of the signal and idler fields to thereby define the unique phase relation between the signal and idler fields; and transmitting the signal and idler fields to the data receiving system, to thereby enable said data receiving system to utilize said unique phase effect value to one of received fields to thereby restore the phase relationship between the fields, and to apply the up conversion process to the received fields.

**25.** The method of Claim 16, wherein said phase effecting includes one of the following: relative delay, material dispersion, spectral phase filtering based on pulse shaping.

**26.** The method of Claim 25, wherein the unique delay value is of the order of the coherence time of the respective field $\tau=1/\Delta\omega$, wherein $\Delta\omega$ is the spectral width of the down converted light.

**27.** The method of Claim 16 comprising modulating at least one of the signal and idler fields in accordance with data to be carried by the optical channel.

**28.** The method of Claim 16, wherein said extraction of data in the data receiving system comprises: affecting a spectral phase of at least one of the signal and idler fields by using the unique phase effect value, thereby restoring a phase relation of the signal and idler fields of the specific channel; and then applying the up conversion process to light, containing the phase-affected signal and idler fields, to thereby enable separation of said channel from a remaining portion of the light.

**29.** A method of multiplexing optical channels comprising:

- producing $N$ optical channels, $N\geq 1$, the optical channel being represented by a pair of down converted signal and idler light fields that are complex conjugates of each other and present a key and its conjugate, thereby enabling modulation of the optical channel in accordance with corresponding data to be carried by said optical channel;
- applying to at least one of the signal and idler fields of the same channel a unique phase effect value to thereby define a unique phase relation between the signal and idler fields for the channel, thereby enabling demultiplexing of light in a data receiving system to extract a specific channel by utilizing the respective unique phase effect and an up conversion process.

**30.** The method of Claim 29, wherein said phase effecting includes one of the following: relative delay, material dispersion, spectral phase filtering based on pulse shaping.

**31.** The method of Claim 30, wherein the unique delay is of the order of the coherence time of the respective field $\tau=1/\Delta\omega$, wherein $\Delta\omega$ is the spectral width of the down converted light.

**32.** The method of Claim 30, wherein a difference between the unique delays associated with different channels is longer than the correlation length of the signal and idler fields.

**33.** The method of Claim 29, wherein said *N* optical channels share the same pair of signal and idler fields.

**34.** The method of Claim 33, wherein said *N* optical channels are produced by pumping a single non-linear light source with pump light to thereby produce down converted broadband signal and idler light portions that are complex conjugates of each other, and splitting one of the signal and idler portions into the *N* spatially separated light components.

**35.** The method of Claim 33, wherein said *N* optical channels are produced by seeding *N* light sources by one noise source, thus causing all the sources to generate the same signal and idler light fields.

**36.** The method of Claim 29, wherein each of said *N* optical channels has its own set of signal and idler light fields.

**37.** The method of Claim 36, wherein said *N* optical channels are produced by pumping *N* uncorrelated light sources to thereby produce *N* pairs of the signal and idler light components, respectively.

**38.** The method of Claim 29, comprising applying data modulation to either one of the signal and idler light fields of the channel.

**39.** The method of Claim 29, wherein the producing of the optical channel represented by the pair of down converted signal and idler light fields and the application of the unique phase effect value to at least one of the fields are carried out in a data transmitting system.

**40.** The method of Claim 29, wherein the optical channel represented by the pair of down converted signal and idler light fields is produced in the data receiving system.

**41.** The method of Claim 40, wherein said application of the unique phase effect value to the light field to be modulated with certain data is implemented by a predefined distance between the data receiving and data transmitting systems, and

an inverse value of said unique phase effect value is applied to the other field in the data receiving system.

**42.** The method of Claim 29, comprising demultiplexing light in a data receiving system for extracting the specific channel, said demultiplexing comprising:

- affecting a phase of at least one of the signal and idler fields in the received light by using an inverse value of said unique phase effect corresponding to said specific channel, to thereby restore phase relation between the signal and idler fields of the specific channel to allow an up conversion process;
- applying the up conversion process to thereby enable restoration and extraction of said specific channel.

**43.** The method of Claim 42, comprising applying said unique phase effect value to a remaining portion of at least one of the signal and idler fields in the up converted light and allowing transmission of the remaining fields to receiver systems.

**44.** A method for use in an optical code division multiple access, the method comprising:

producing *N* optical channels each presented by a key and its conjugate in the form of signal and idler down converted light components that are complex conjugates of each other, thereby enabling modulation each of the channels in accordance with respective data to be carried by the channel; uniquely encoding each of the channels by phase affecting at least one of the signal and idler components of the channel using a unique value of the phase effect different from those applied to the other channels to thereby define a unique phase relation between the signal and idler fields of each channel, and allowing transmission of the down converted components towards receiving systems to thereby enable extracting the specific channel from all other channels in the respective one of the receiving systems by separating between the signal and idler fields, affecting a phase of at least one of the signal or idler fields using an inverse value of the unique phase effect corresponding to said specific channel to thereby restore a phase relation between the signal and idler fields of the specific channel; and applying an up conversion to the received light, thereby

restoring the specific optical channel and enabling its separation from a remaining part of the received light;

45. A method for use in an optical code division multiple access, the method comprising:

producing by each of data receiving systems an optical channel presented by a key and its conjugate in the form of signal and idler down converted light components that are complex conjugates of each other and transmitting one of said fields through a transmitting channel to be received in a corresponding data transmitting system, thereby allowing data modulation of said one of the fields in the data transmitting system and returning the modulated field to the data receiving system, a predefined distance between the corresponding data receiving and data transmitting systems resulting in application of a unique value of the phase effect value to said one of the fields defining a unique phase relation between the signal and idler fields of said channel;

applying an inverse value of said unique phase effect value to the other field; and

upon receiving the returned modulated phase affected field, applying an up conversion process to both of the fields to thereby extract said data.

46. The method of Claim 44, comprising applying said unique phase effect to the other of the signal and idler fields in the remaining part of the up converted light, and allowing transmission of the remaining light to receiving systems.

47. An optical multiplexer system comprising:

- a light source arrangement for producing $N$ optical channels each represented by down converted signal and idler fields that are complex conjugates of each other and represent key and its conjugate fields;
- a phase affecting utility accommodated in the optical paths of the key fields and operable to apply a unique phase effect value to each of the key fields different from those applied to the other key fields;
- an output coupler for combining the phase affected key fields and the conjugate key fields to allow their transmission through an optical network.

**48.** An optical demultiplexer system operable for receiving input multi-channel light and extract therefrom a specific optical channel, the system comprising:

- a frequency filter for spatially separating between down converted signal and idler fields in the received light, said signal and idler fields being indicative of key and its conjugate of the specific channel;
- a phase affecting utility preprogrammed to affect a phase of the conjugate field by applying thereto an inverse value of a predetermined unique phase effect corresponding to the specific channel; and
- a light source arrangement operating to apply an up conversion process to the down converted fields, thereby enabling extraction of the specific channel.

**49.** An optical multiplexer/demultiplexer system comprising:

- a light source arrangement operating to apply a down conversion process to light intended to carry data of a specific optical channel, down converted light including signal and idler fields that are complex conjugates of each other and represent key and its conjugate fields of the specific channel;
- a frequency filter for spatially separating between the down converted signal and idler fields;
- a phase affecting utility operable to apply a unique phase effect value to a light field;
- a light source arrangement operating to apply an up conversion process to the down converted fields, thereby enabling extraction of the specific channel.

**50.** A source for generating a broadband key and its conjugate to be used as an optical channel in a code division multiple access system, the source comprising a non-linear optical arrangement operable to receive input light and produce output down converted signal and idler fields being complex conjugates of each other and therefore presenting the key and its conjugate.

**51.** The source of Claim 50, wherein said arrangement comprises a resonant cavity formed by at least one non-linear medium between two mirrors, and a phase shaper

arrangement operable to effect spectral phase of at least one of the down converted light fields to thereby introduce a certain phase relation between the down converted fields and reduce an effect of up conversion for broadband oscillations of the down converted light fields while propagating through said arrangement.

**52.** The source of Claim 51, wherein said phase shaper is configured to introduce a relative delay between the down converted fields emitted by the non-linear medium, and restore the phase relation of the fields prior to further passing through said medium while propagating through the resonant cavity.

**53.** The source of Claim 52, wherein said relative delay is of the order of the coherence time of the respective down converted field $\tau=1/\Delta\omega$, wherein $\Delta\omega$ is the spectral width of the down converted light.

**54.** The source of Claim 51, comprising the single non-linear medium, and two phase shaper units accommodated, respectively, upstream and downstream of said non-linear medium.

**55.** The source of Claim 51, comprising a first non-linear medium pumped by the input light to produce the down converted fields, a second non-linear medium in the optical path of the down converted fields, and two phase shaper units accommodated at opposite input/output sides of the second medium.

**56.** A method for producing broadband down converted light fields, the method comprising passing input light through a resonant non-linear optical arrangement, and affecting phases of down converted light fields while propagating through said arrangement to reduce an effect of up conversion for broadband oscillations of said down converted fields.

**57.** A source for broadband spectrally correlated light, the source comprising a resonant non-linear optical arrangement having a cavity with at least one non-linear optical medium between two mirrors, and a phase shaper arrangement, said phase shaper arrangement being operable to introduce a certain phase relation between the down converted fields and reduce an effect of up conversion of down converted light propagating through the optical arrangement.

**58.** The source of Claim 57, wherein said phase shaper arrangement is operable to introduce a relative delay or dispersion between the signal and idler fields.

**59.** The arrangement of Claim 57, wherein said cavity comprises a single non-linear optical medium to be pumped by input light to emit down converted signal and idler light fields, and two phase shaper units accommodated, respectively, upstream and downstream of said medium.

**60.** The arrangement of Claim 57, wherein said cavity comprises a first non-linear medium to be pumped by input light to emit the down converted light fields, a second non-linear medium in the optical path of said down converted fields, and two phase shaper units accommodated at opposite input/output sides, respectively, of said second medium.